Impact of Climate Change on WEPP Runoff and Soil Loss Predictions in Iowa

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Analyses of the climate data record shows that precipitation patterns are changing now in the United States (SWCS, 2003). Although climate change affects soil and water resources on agricultural lands in many ways, actual effects of global climate change to increase the risk of surface runoff and soil erosion is not clear. CLIGEN (v.5x), a stochastic climate generator which is used in the Water Erosion Prediction Project (WEPP, Flanagan and Nearing, 1995; Flanagan et al., 2007; Flanagan et al., 2012) and some other models, currently employs a dataset which was based on historical weather data through 1992 (Nicks et al., 1995). This was recently updated by our research group to utilize temporally consistent climate data from 1974 to 2013 at 2600+ stations across the United States.

This study investigated the impacts of utilizing the updated input data to CLIGEN based upon 1974-2013 weather station data compared to the existing CLIGEN database containing stations with variable years of record through 1992. Changes in climate parameters for a specific location, CLIGEN-predicted daily weather (temperatures, precipitation, intensity, etc.), and WEPP-predicted runoff and soil loss were determined. The results were examined to identify any possible changes in generated climate and impacts on runoff and soil loss. The selected region for the modeling was central Iowa, where a major part of the Corn Belt is located. Four management scenarios were studied: tilled fallow conditions, corn-soybean rotations under conventional tillage, corn-soybean rotations under conservation (chisel) tillage, and corn-soybean rotations under no-till. A slope profile of 22.1 m length, and uniform 9% gradient, which corresponds to the standard USLE unit plot conditions, a clay loam soil, and weather data from the Webster City station in Iowa were employed. Under the fallow management conditions, changes in the WEPP model predictions derived by using the current and updated CLIGEN datasets were only induced by variation of the climate input parameters. Thus, the differences in runoff and soil loss results in that case may represent at least partially the effects of weather variations due to climate change (Baffaut et al., 1996).

Results showed an increase in runoff and soil loss for all scenarios, which was attributed to the increased precipitation (Table 1). Average annual daily T_{min} and T_{max} decreased 0.5 °C and 0.4 °C, respectively. The variance of percent change of annual predicted runoff was low for the different management systems. Increase of predicted soil loss in the no-till system was less than for the others, which indicates its effectiveness in controlling soil erosion under changing climate conditions. Predicted soil loss increased the most for the conventional tillage system in which, during seedbed preparation, the intensely tilled and unprotected soil facilitated surface erosion. The results here have implications for the conservation of soil and water resources in the region.

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Table 1. Comparing simulated average annual precipitation, runoff and soil loss, and average annual daily T_{max} and T_{min} and their changes for the two climate sets for Webster City, Iowa.

Climate sets	**CLIGEN and WEPP predictions**	**Management**			
		Fallow	**Corn-soybean rotation**		
		Tilled fallow	**Conventional tillage**	**Conservation tillage**	**No-till**
Climate data (1905 to 1992)	Precipitation (mm)	750.1	750.1	750.1	750.1
	T_{max} (°C)	15.0	15.0	15.0	15.0
	T_{min} (°C)	3.0	3.0	3.0	3.0
	Runoff (mm)	205.2	176.3	175.8	148.3
	Soil loss (t/ha)	101.1	37.3	30.3	3.5
Climate data (1974 to 2013)	Precipitation (mm)	861.6	861.6	861.6	861.6
	T_{max} (°C)	14.6	14.6	14.6	14.6
	T_{min} (°C)	2.5	2.5	2.5	2.5
	Runoff (mm)	259.8	222.0	222.0	190.2
	Soil loss (t/ha)	138.1	44.3	34.6	3.9
Changes	Precipitation (%)	14.9	14.9	14.9	14.9
	T_{max} (°C)	-0.4	-0.4	-0.4	-0.4
	T_{min} (°C)	-0.5	-0.5	-0.5	-0.5
	Runoff (%)	26.6	25.9	26.3	28.3
	Soil loss (%)	36.7	18.6	14.0	13.6

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